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Chen

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(54) **BACKLIGHT MODULE AND LIGHTING KEYBOARD**

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(30) **Foreign Application Priority Data**

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F21V 8/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 6/0045*** (2013.01); ***G02B 6/0036*** (2013.01)

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CPC G02B 6/0031; G02B 6/0088; G02B 6/005; G02B 6/0055; G02B 6/0045; G02B 6/0036; H01H 13/023; H01H 2219/044; H01H 2219/062; H01H 2219/06
See application file for complete search history.

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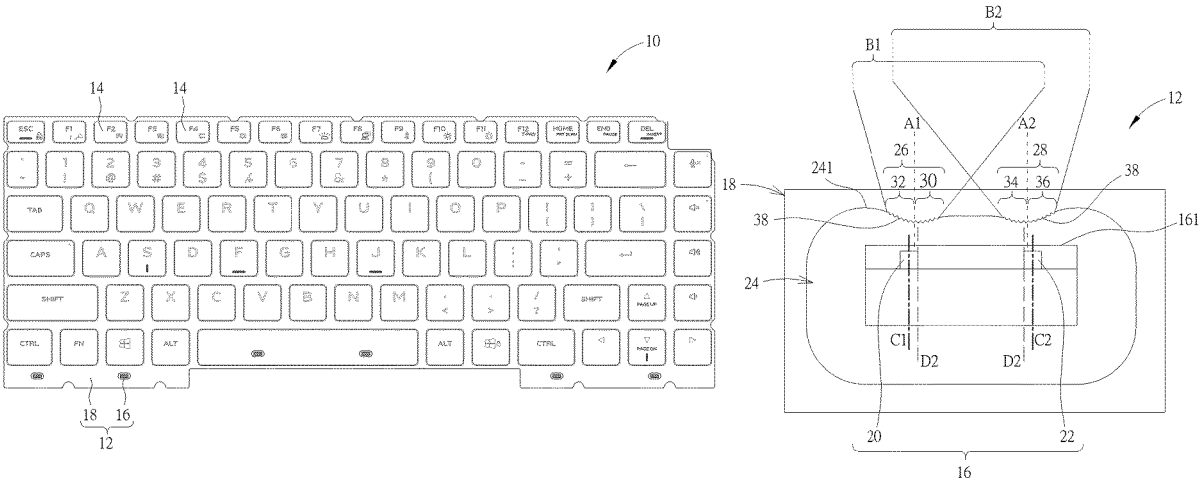
(57) **ABSTRACT**

A backlight module is disposed under a plurality of key-switches of a lighting keyboard. The backlight module includes a lighting chip and a light guide plate. The lighting chip has a first illumination unit and a second illumination unit arranged side by side. The light guide plate has a hole structure where inside the lighting chip is disposed. A lateral side of the hole structure facing an illumination surface of the lighting chip includes a first area and a second area formed in a non-linear manner, respectively corresponding to the first illumination unit and the second illumination unit. The first area guides a first output beam of the first illumination unit toward the second area. The second area guides a second output beam of the second illumination unit toward the first area.

18 Claims, 6 Drawing Sheets



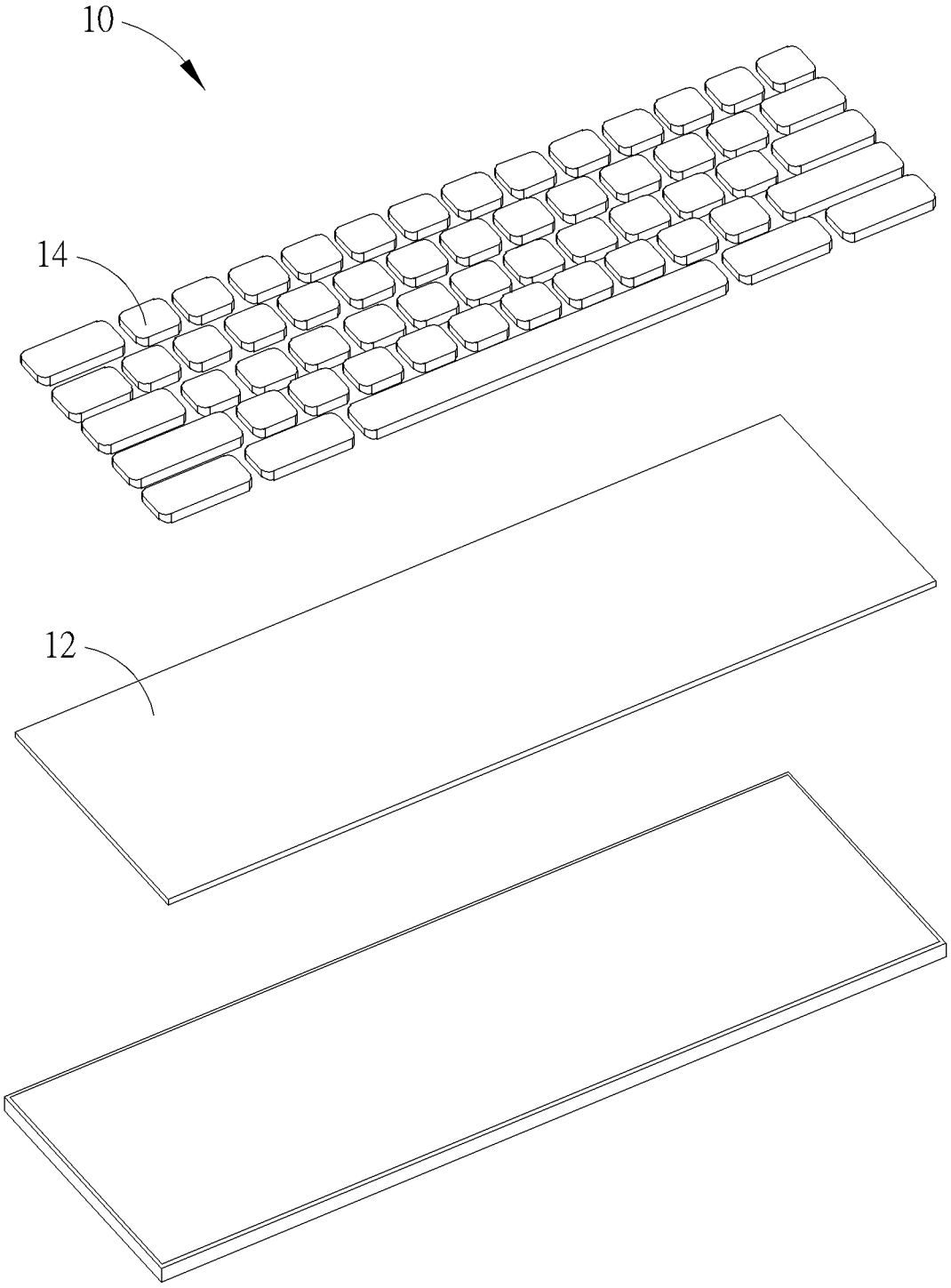
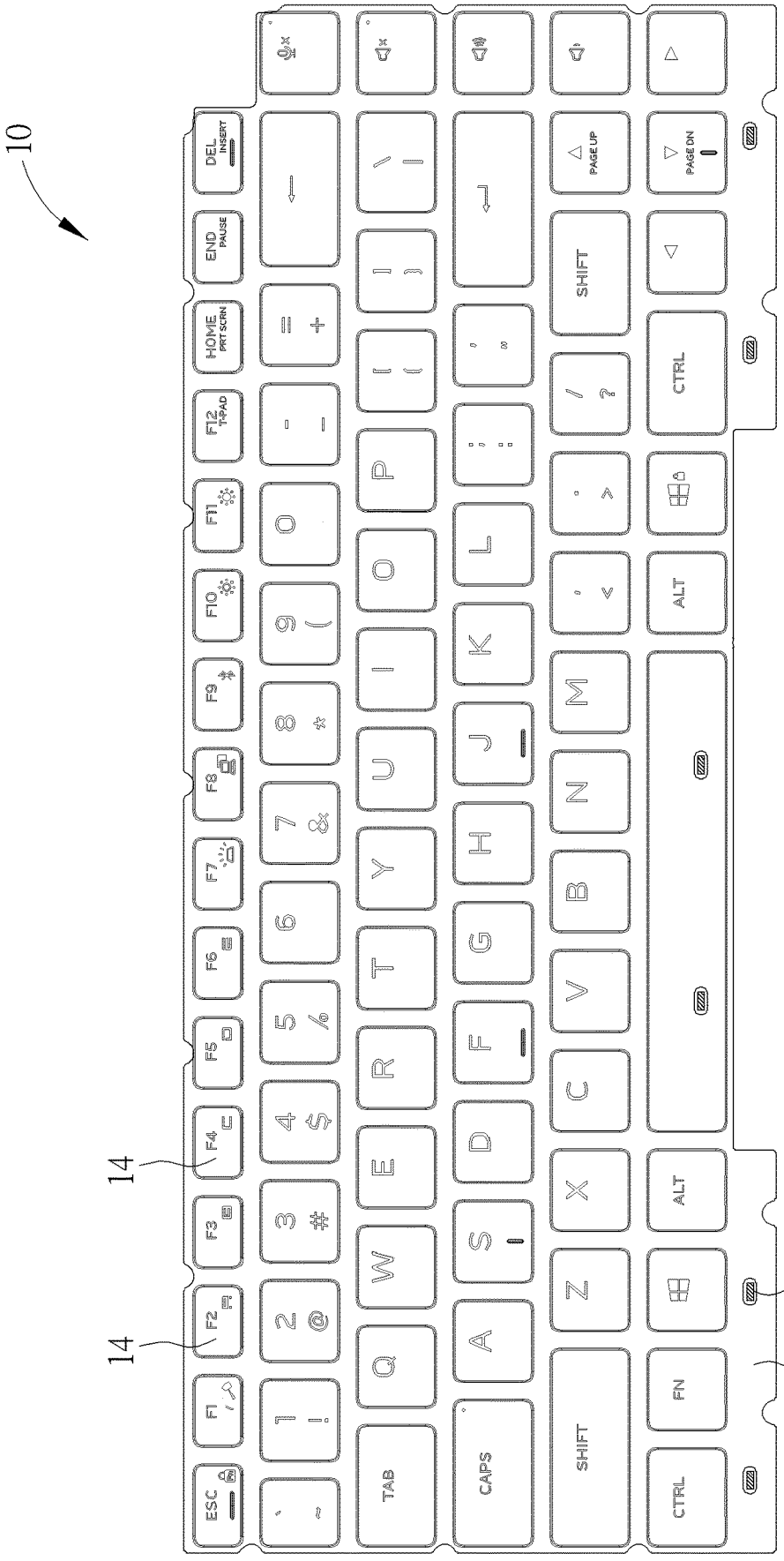


FIG. 1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DEL INSERT
END PAUSE
HOME PRT SCRN
F12 T-PAD
F11
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F9
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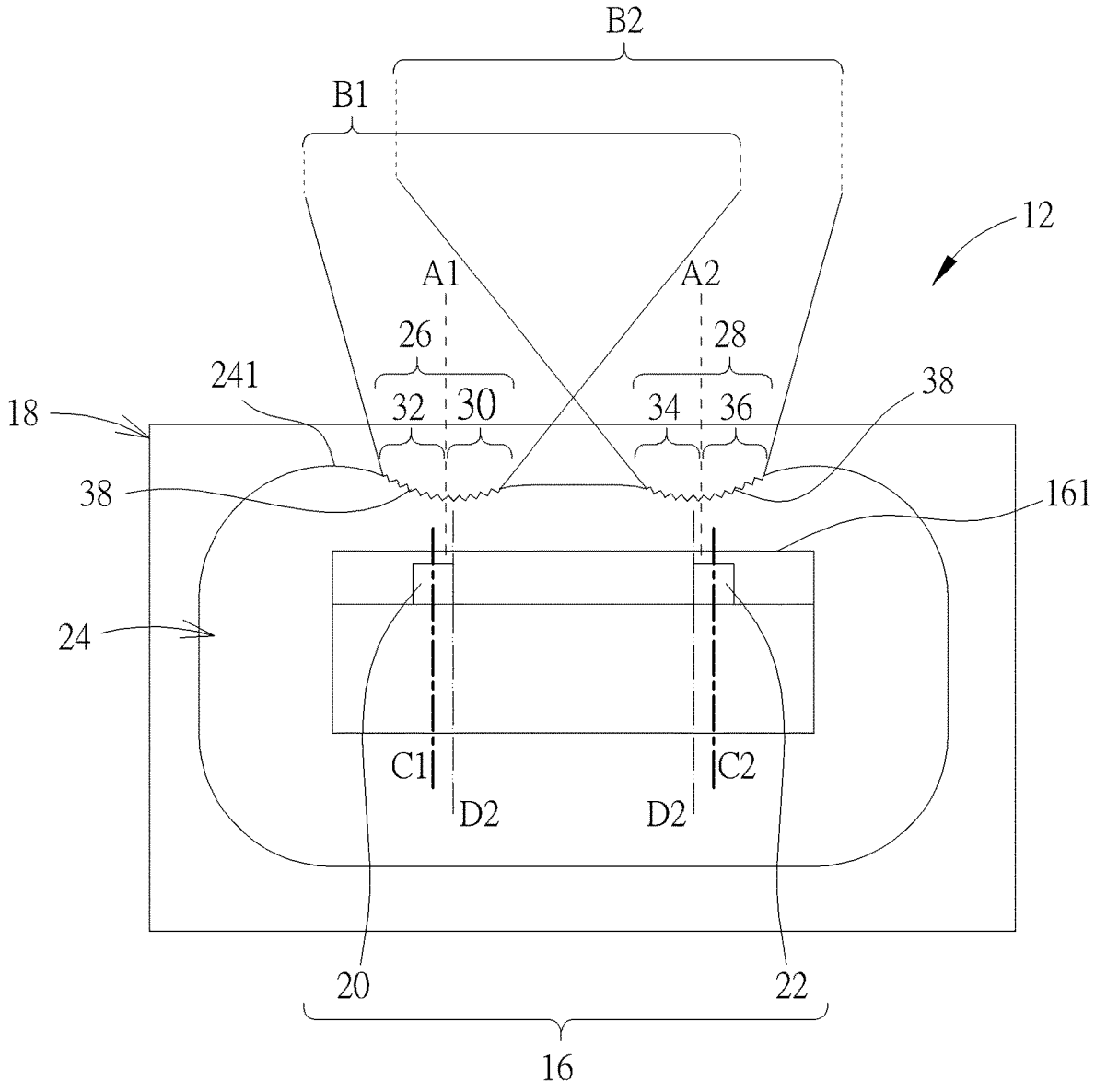
F3
F2
F1

FIG. 2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A2
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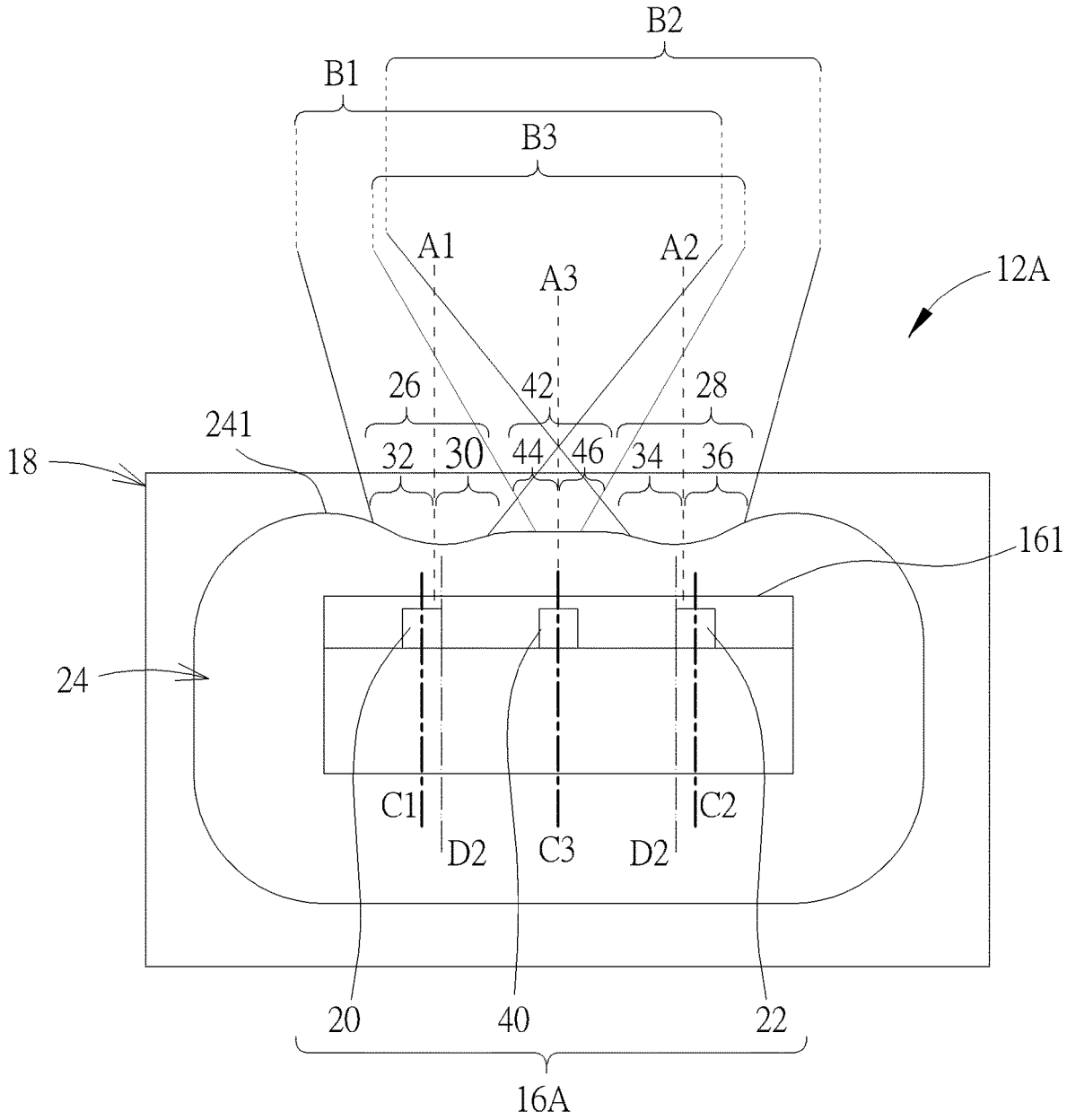
C2
D2
D2
20
22
16

FIG. 3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18
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D2
C3
D2
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40
22
16A

FIG. 4

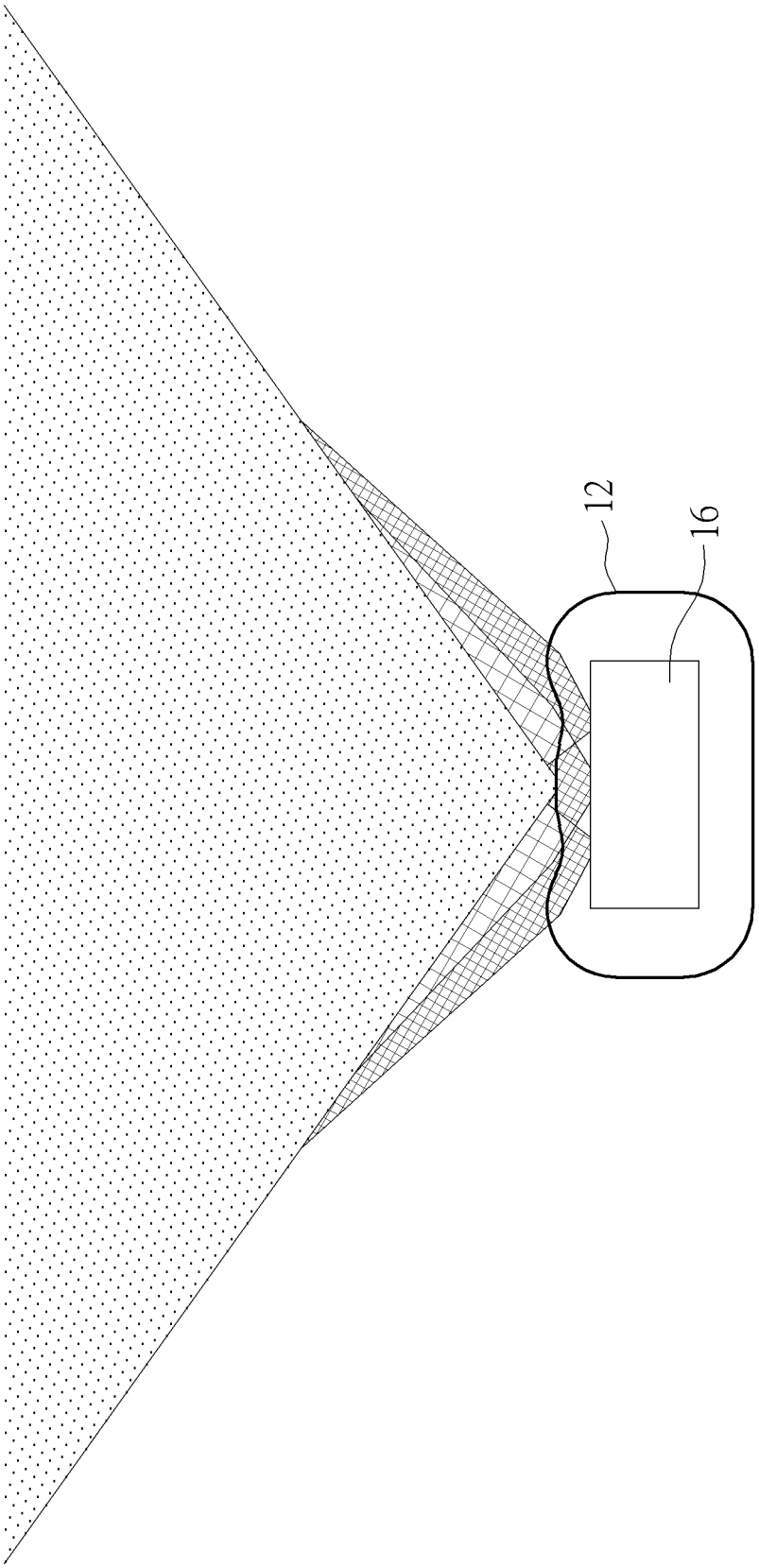

FIG. 5

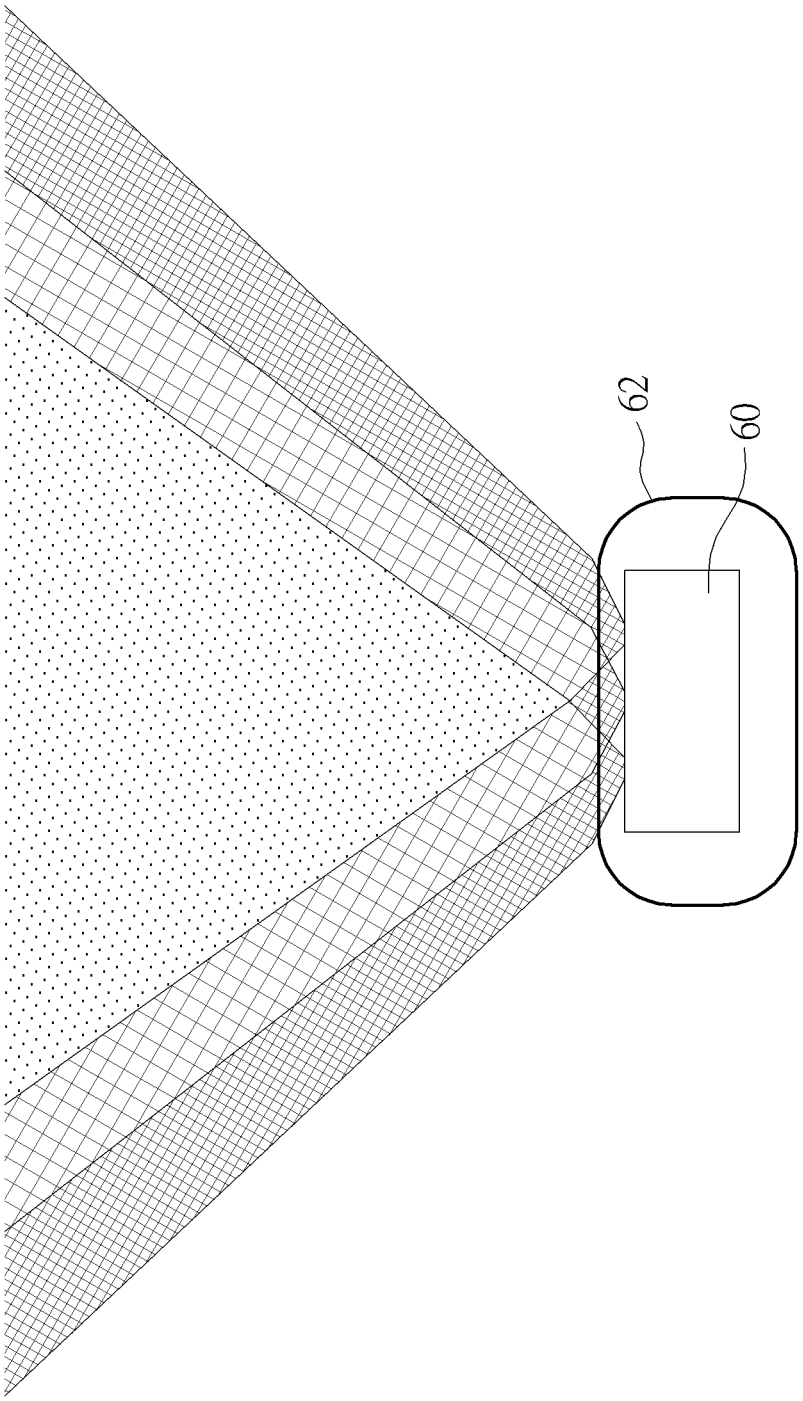

FIG. 6 PRIOR ART

BACKLIGHT MODULE AND LIGHTING KEYBOARD

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 63/291,470, filed on Dec. 20, 2021. The content of the application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a backlight module and a lighting keyboard, and more particularly, to a backlight module having a shortest light mixing distance and a related lighting keyboard.

2. Description of the Prior Art

Please refer to FIG. **6**. FIG. **6** is an application diagram of a backlight module **60** and a lighting chip **62** in prior art. The lateral side of the hole of the backlight module **60** used to accommodate the lighting chip **62** is a straight side shape. Beams with different colors emitted by illumination units of the lighting chip **62** are mixed at a distance far from the lighting chip **62**. For example, the illumination range drawn in grid is represented as different color beams emitted by the illumination units, such as the red beam, the blue beam and the yellow beam; the illumination range drawn in dots is represented as the white beam formed by mixing of the foresaid color beams. Generally, the light mixing extension distance in prior art is about 7 mm to 15 mm, which easily results in chromatic aberration, and the chromatic aberration is more obvious in position close to the lighting chip **62**.

SUMMARY OF THE INVENTION

The present invention provides a backlight module having a shortest light mixing distance and a related lighting keyboard for solving above drawbacks.

According to the claimed invention, a backlight module is disposed under a plurality of keyswitches of a lighting keyboard. The backlight module includes a lighting chip and a light guide plate. The lighting chip includes a first illumination unit and a second illumination unit arranged side by side. The light guide plate includes a hole structure where inside the lighting chip is disposed. A lateral side of the hole structure facing an illumination surface of the lighting chip includes a first area and a second area formed in a non-linear manner. The first area and the second area respectively correspond to the first illumination unit and the second illumination unit. The first area guides a first output beam emitted by the first illumination unit toward the second area, and the second area guides a second output beam emitted by the second illumination unit toward the first area.

According to the claimed invention, a lighting keyboard includes a plurality of keyswitches and a backlight module. The backlight module is disposed under the plurality of keyswitches of a lighting keyboard. The backlight module includes a lighting chip and a light guide plate. The lighting chip includes a first illumination unit and a second illumination unit arranged side by side. The light guide plate includes a hole structure where inside the lighting chip is disposed. A lateral side of the hole structure facing an illumination surface of the lighting chip includes a first area and a second area formed in a non-linear manner. The first area and the second area respectively correspond to the first illumination unit and the second illumination unit. The first area guides a first output beam emitted by the first illumination unit toward the second area, and the second area guides a second output beam emitted by the second illumination unit toward the first area.

The backlight module of the present invention can design the first area, the second area and the third area of the lateral side of the hole structure within the light guide plate, which is used to accommodate the lighting chip and faces the illumination surface of the lighting chip, as the arc curve, or the aspheric shape or the hyperbolic shape mentioned as above; an actual shape of the first area, the second area and the third area is not limited to the foresaid embodiment. An intersection of the arc curve and other straight lateral sides of the hole structure can be chamfered. The first area located on the left side of the hole structure can guide the output beam toward the right side, and the second area located on the right side of the hole structure can guide the output beam toward the left side, and the third area located on the middle of the hole structure can optionally expand the beam angle of the lighting chip, so that the illumination units of the lighting chip can be uniformly mixed in the very short distance.

In conclusion, the backlight module and the lighting keyboard of the present invention can adjust a curvature of the lateral side of the hole structure to improve the light mixing effect of the lighting chip for more uniform and avoiding chromatic aberration, in accordance with a light distribution curve and usage requirement of the lighting chip. The light mixing function of the lighting chip is not limited to the two-color light mixing embodiment or the three-color light mixing embodiment, and depends on the design demand. The light mixing extension distance in the prior art is about 7 mm to 15 mm; comparing to the prior art, the present invention can greatly shorten the light mixing extension distance to less than 2 mm, thereby reducing the waste of mechanical space and product weight.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of a lighting keyboard according to an embodiment of the present invention.

FIG. **2** is a partial diagram of the lighting keyboard according to the embodiment of the present invention.

FIG. **3** is a diagram of a backlight module according to the embodiment of the present invention.

FIG. **4** is a diagram of the backlight module according to another embodiment of the present invention.

FIG. **5** is an application diagram of the backlight module according to the embodiment of the present invention.

FIG. **6** is an application diagram of a backlight module and a lighting chip in prior art.

DETAILED DESCRIPTION

Please refer to FIG. **1** and FIG. **2**. FIG. **1** is a diagram of a lighting keyboard **10** according to an embodiment of the present invention. FIG. **2** is a partial diagram of the lighting keyboard **10** according to the embodiment of the present

invention. The lighting keyboard **10** can include a backlight module **12** and a plurality of lighting keyswitches **14**. A number and arrangement of the lighting keyswitch **14** can depend on a design demand of the lighting keyboard **10**, and a detailed description is omitted herein for simplicity. Each lighting keyswitch **14** can include a substrate, a thin film circuit board, a keycap, a lifting mechanism and a resilient recovering component. The keycap can have a character or a symbol. The thin film circuit board can have a switch. The lifting mechanism can be movably disposed on the substrate and used to move the keycap upwardly and downwardly to actuate or be distant from the switch. A resilient recovering force stored in compression of the resilient recovering component can be released to move the keycap back to an original position.

Please refer to FIG. **2** and FIG. **3**. FIG. **3** is a diagram of the backlight module **12** according to the embodiment of the present invention. The backlight module **12** can be disposed under the plurality of lighting keyswitches **14**. The backlight module **12** can include a lighting chip **16** and a light guide plate **18**. The lighting chip **16** can include a first illumination unit **20** and a second illumination unit **22** arranged side by side. The light guide plate **18** can include a hole structure **24** used to accommodate the lighting chip **16**. A shape of the hole structure **24** is not limited to the embodiment shown in FIG. **3** and depends on the design demand. The first illumination unit **20** and the second illumination unit **22** can emit beams with different colors outwardly. An illumination direction of the illumination unit can correspond to an illumination surface **161** of the lighting chip **16**. A lateral side **241** of the hole structure **24** facing the illumination surface **161** of the lighting chip **16** can at least include a first area **26** and a second area **28** formed in a non-linear manner. The first area **26** and the second area **28** can respectively correspond to the first illumination unit **20** and the second illumination unit **22**. The foresaid non-linear manner can be interpreted as an edge curve of the first area **26** and the second area **28** from the top view.

The first area **26** can guide a first output beam B**1** emitted by the first illumination unit **20** toward the second area **28**. The first area **26** can be at least divided into a first divergent part **30** and a first convergent part **32**. A boundary A**1** between the first divergent part **30** and the first convergent part **32** can point toward a position between a central axle C**1** of the first illumination unit **20** and an adjacent edge D**1** of the second illumination unit **22**. A combination of the first divergent part **30** and the first convergent part **32** of the first area **26** can be an aspheric shape or a hyperbolic shape, and an actual shape can depend on the design demand. The first divergent part **30** can guide the first output beam B**1** toward the second area **28**, and the first convergent part **32** can guide the first output beam B**1** toward the front of the lighting chip **16**.

The second area **28** can guide a second output beam B**2** emitted by the second illumination unit **22** toward the first area **26**. The second area **28** can be at least divided into a second divergent part **34** and a second convergent part **36**. A boundary A**2** between the second divergent part **34** and the second convergent part **36** can point toward a position between a central axle C**2** of the second illumination unit **22** and an adjacent edge D**2** of the first illumination unit **20**. A combination of the second divergent part **34** and the second convergent part **36** of the second area **28** can optionally be the aspheric shape or the hyperbolic shape, which may be the same as or different from the shape of the first divergent part **30** and the first convergent part **32**, and the actual shape can depend on the design demand. The second divergent part **34** can guide the second output beam B**2** toward the first area **26**, and the second convergent part **36** can guide the second output beam B**2** toward the front of the lighting chip **16**.

Therefore, design of the first area **26** and the second area **28** within the hole structure **24** of the light guide plate **18** can guide the first output beam B**1** and the second output beam B**2** to mix each other in a very short distance in front of the lighting chip **16**, for achieving a light mixing effect. Besides, the light guide plate **18** can optionally include a microstructural layer **38** disposed on the lateral side **241** of the hole structure **24**. The microstructural layer **38** can be mainly distributed within a range of the first area **26** and the second area **28**, and used to diffuse the first output beam B**1** and the second output beam B**2**, so that the first output beam B**1** and the second output beam B**2** can be mixed each other in the very short distance for the light uniformly mixing effect.

Please refer to FIG. **4**. FIG. **4** is a diagram of the backlight module **12**A according to another embodiment of the present invention. In this embodiment, elements having the same numerals as ones of the foresaid embodiment have the same structures and functions, and the detailed description is omitted herein for simplicity. The lighting chip **16**A of the backlight module **12**A can further include a third illumination unit **40** located between the first illumination unit **20** and the second illumination unit **22**. Accordingly, the lateral side **241** of the hole structure **24** can further include a third area **42** located between the first area **26** and the second area **28** and corresponding to the third illumination unit **40**. The third illumination unit **40** can emit the third output beam B**3** toward the third area **42**, and can be mixed with the first output beam B**1** and the second output beam B**2** in the very short distance for the light uniformly mixing effect.

The third area **42** can be a plane shape or an arc shape. If the third area **42** is the plane shape, the third output beam B**3** can be emitted in accordance with a beam angle of the third illumination unit **40**, and the third output beam B**3** may be slightly refracted due to the plane shape of the third area **42**. If the third area **42** is the arc shape, the third area **42** can optionally include two light guiding parts **44** and **46**. The light guiding parts **44** and **46** can be the aspheric shape or the hyperbolic shape, which depends on the design demand. The light guiding parts **44** and **46** can guide the third output beam B**3** emitted by the third illumination unit **40** respectively toward the first area **26** and the second area **28**, so as to mix with the first output beam B**1** and the second output beam B**2**. In the embodiment, a boundary A**3** between the two light guiding parts **44** and **46** can point toward a central axle C**3** of the third illumination unit **40**, which means the boundary A**3** may align with the central axle C**3**, or misalignment error of the boundary A**3** and the central axle C**3** is smaller than a preset threshold.

Please refer to FIG. **5**. FIG. **5** is an application diagram of the backlight module **12** according to the embodiment of the present invention. As shown in FIG. **5**, the output beams with several colors (which means an illumination range drawn in grid) emitted by the lighting chip **16** can complete a light mixing function within a light mixing extension distance about 2 mm in front of the lighting chip **16**, so that the white beam (which means an illumination range drawn in dots) can be emitted to illuminate the lighting keyswitch **14**. Thus, the lighting chips **16** installed in the bottom of the lighting keyboard **10** can illuminate the plurality of lighting keyswitches **14**, as the embodiment shown in FIG. **2**.

The backlight module of the present invention can design the first area, the second area and the third area of the lateral side of the hole structure within the light guide plate, which is used to accommodate the lighting chip and faces the

illumination surface of the lighting chip, as the arc curve, or the aspheric shape or the hyperbolic shape mentioned as above; an actual shape of the first area, the second area and the third area is not limited to the foresaid embodiment. An intersection of the arc curve and other straight lateral sides of the hole structure can be chamfered. The first area located on the left side of the hole structure can guide the output beam toward the right side, and the second area located on the right side of the hole structure can guide the output beam toward the left side, and the third area located on the middle of the hole structure can optionally expand the beam angle of the lighting chip, so that the illumination units of the lighting chip can be uniformly mixed in the very short distance.

In conclusion, the backlight module and the lighting keyboard of the present invention can adjust a curvature of the lateral side of the hole structure to improve the light mixing effect of the lighting chip for more uniform and avoiding chromatic aberration, in accordance with a light distribution curve and usage requirement of the lighting chip. The light mixing function of the lighting chip is not limited to the two-color light mixing embodiment or the three-color light mixing embodiment, and depends on the design demand. The light mixing extension distance in the prior art is about 7 mm to 15 mm; comparing to the prior art, the present invention can greatly shorten the light mixing extension distance to less than 2 mm, thereby reducing the waste of mechanical space and product weight.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A backlight module disposed under a plurality of keyswitches of a lighting keyboard, the backlight module comprising:

a lighting module, comprising a first illumination unit and a second illumination unit arranged side by side; and

a light guide plate, comprising a hole structure wherein the lighting module is disposed within the hole structure, a lateral side of the hole structure facing an illumination surface of the lighting module comprising a first area and a second area formed in a non-linear manner, the first area and the second area respectively corresponding to the first illumination unit and the second illumination unit, a first output beam from the first area emitting towards the second area, and a second output beam from the second area emitting towards the first area;

wherein a first central optical axis of the first output beam is intersected with a central boundary between the first illumination unit and the second illumination unit, and a second central optical axis of the second output beam is intersected with the central boundary.

2. The backlight module of claim **1**, wherein the first area comprises a first divergent part and a first convergent part, a boundary of the first divergent part and the first convergent part points toward a position between a central axle of the first illumination unit and an adjacent edge of the second illumination unit.

3. The backlight module of claim **1**, wherein the second area comprises a second divergent part and a second convergent part, a boundary of the second divergent part and the second convergent part points toward a position between a central axle of the second illumination unit and an adjacent edge of the first illumination unit.

4. The backlight module of claim **1**, wherein at least one area of the first area and the second area is an aspheric shape or a hyperbolic shape.

5. The backlight module of claim **1**, wherein the light guide plate further comprises a microstructural layer disposed on the lateral side of the hole structure, and used to diffuse the first output beam and the second output beam.

6. The backlight module of claim **1**, wherein the lighting module further comprises a third illumination unit located between the first illumination unit and the second illumination unit, the lateral side of the hole structure further comprises a third area located between the first area and the second area and corresponding to the third illumination unit.

7. The backlight module of claim **6**, wherein the third area is a plane shape or an arc shape.

8. The backlight module of claim **6**, wherein the third area comprises two light guiding parts adapted to guide a third output beam emitted by the third illumination unit respectively toward the first area and the second area.

9. The backlight module of claim **8**, wherein a boundary of the two light guiding parts aligns with a central axle of the third illumination unit.

10. A lighting keyboard, comprising:

a plurality of keyswitches; and

a backlight module disposed under the plurality of keyswitches of a lighting keyboard, the backlight module comprising

a lighting module, comprising a first illumination unit and a second illumination unit arranged side by side; and

a light guide plate, comprising a hole structure wherein the lighting module is disposed within the hole structure, a lateral side of the hole structure facing an illumination surface of the lighting module comprising a first area and a second area formed in a non-linear manner, the first area and the second area respectively corresponding to the first illumination unit and the second illumination unit, a first output beam from the first area emitting towards the second area, and a second output beam from the second area emitting towards the first area;

wherein a first central optical axis of the first output beam is intersected with a central boundary between the first illumination unit and the second illumination unit, and a second central optical axis of the second output beam is intersected with the central boundary.

11. The backlight module of claim **10**, wherein the first area comprises a first divergent part and a first convergent part, a boundary of the first divergent part and the first convergent part points toward a position between a central axle of the first illumination unit and an adjacent edge of the second illumination unit.

12. The backlight module of claim **10**, wherein the second area comprises a second divergent part and a second convergent part, a boundary of the second divergent part and the second convergent part points toward a position between a central axle of the second illumination unit and an adjacent edge of the first illumination unit.

13. The backlight module of claim **10**, wherein at least one area of the first area and the second area is an aspheric shape or a hyperbolic shape.

14. The backlight module of claim **10**, wherein the light guide plate further comprises a microstructural layer disposed on the lateral side of the hole structure, and used to diffuse the first output beam and the second output beam.

15. The backlight module of claim 10, wherein the lighting module further comprises a third illumination unit located between the first illumination unit and the second illumination unit, the lateral side of the hole structure further comprises a third area located between the first area and the second area and corresponding to the third illumination unit.

16. The backlight module of claim 15, wherein the third area is a plane shape or an arc shape.

17. The backlight module of claim 15, wherein the third area comprises two light guiding parts adapted to guide a third second output beam emitted by the third illumination unit respectively toward the first area and the second area.

18. The backlight module of claim 17, wherein a boundary of the two light guiding parts aligns with a central axle of the third illumination unit.

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